GWDS the Revolutionary Economic, Innovative and Safe Solution to Further Improve the Quality of Blow Molded Parts

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Actual situation in extrusion blow molding

The wall thickness of blow molded articles is always the smallest at those locations where the stretching ratio is the biggest when blowing the parison into the final geometry of the article. This is at least true for small articles which have to be produced using a die that is smaller than 50 mm in diameter. As an example for small bottles the wall thickness is always the smallest at the bottom region perpendicular to the welding line. As at least a certain wall thickness is demanded to meet the required useful properties the flow channal gap of the die has to be increased to reach the aspired wall thickness. As a consequence the wall thickness at both ends of the welding line where no stretching occurrs gets much bigger than it is intended and that it would be necessary. That affords more raw material, and it increases the energy consumption. Aditionally it extends the cycle times, as the wall sections which are too big need to be cooled for a longer time. But this also limits the capacity of the blow molding machines and thus also the productivity of the comany. For a long time it was not at all possible to alter the wall thickness over the circumfernce of the parison at a locally limited area for small blow molded articles while the parison is discharged.
For greater die diameters the well established PWDS-solution can be used to alter the wall thickness over the circumference while the parison is extracted. But the PWDS-system is rather sophisticated and therefor extremely expensive. Furthermore the PWDS-system has to be maintained regularly as it posseses different devices which might fail and cause machine break downs. In both cases this it is inevitable that in those times the machine is not available to produce parts.That is why for many articles it is even questionable whether there exists a reasonable relation between the necessary investment and the benefit that is reached. So for decades there was a need for a solution which can be used for all blow molded articles independantly whether they are small or big and independantly what geometry they might have. And of course for a long time there was also a long for an economic solution that costs a minimum of a PWDS-system, that needs no regular maintenance and that can not cause nonoperating steps.

Comparison between rules to design conventional dies for blow molding and those for GWDS-dies

The general designing rules for dies for exrusion blow molding have been established in the last century and are still state of the art nowadays. They have not been put into question and thus kept unchanged. Most dies which are actually designed and offered for extrusion blow molding have still a conical flow channel. As well the die as also the mandrel are conical at their ends (Fig. 1).
That helps to alter the wall thickness of the parison homogeniuously over the complete circumference. Conventional conical dies are also well suited to compensate the elongation of the parison due to its increasing weight. But conventional conical dies are of extreme disadvantage in case you want to alter the wall thickness differently over the circumference of the parison. That is why it was necessary to break fundmentally with the traditional well established design strategies for dies to realize the patented (US 9,676,134 B2) GWDS-technology (Fig.2). It is the only available solution which can alter the wall thickness of

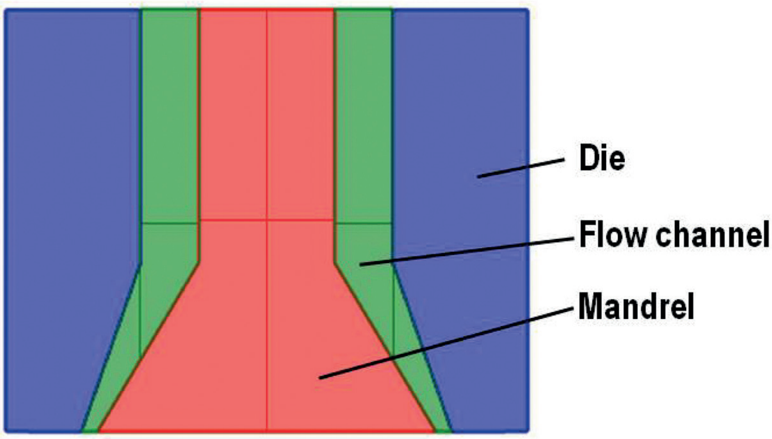


Fig. 1
Cross section of a conventionally designed conical die

the parison differently over its circumference while it is extracted that can be used universally. This because the GWDS-technology is not subject to limitations neither regarding the die diameters nor regarding of the individual geometry of the part. To enable to alter the wall thickness of the parison differently over its circumfernce the mandrel should be designed to be not conical but to be predominantly cylindrical at its end. Additionally the die should either be cylindrical at its end or converging with the smallest diameter at its end. Furthermore the diameter of the mandrel should be smaller than that of the die end.

Advantage of GWDS designed dies

In this case the mandrel can be pushed out of the die without touching it. When this is done the end of the mandrel is no longer part of the flow channel so that the parison simply glides over the end region of the mandrel which is protruded from the die. Now the mandrel region which protudes can be profiled in any shape that is necessary for a special region of the parison. As long as the protruded profiled mandrel end is outside of the die and thus not part of the flow channel the thickness of the parison is determined by the flow channel gap which exists at the end of the die. The wall thickness of the parison is not at all affected by the profiled end of the mandrel which is situated outside of the die. It simply gliedes over it without that the wall thickness which is built by the gap at the die end is influenced or modified by the profiled end region of the mandrel. This because it is no longer part of the flow channel. But when the part of the parison is discharged that needs the variation in the thickness over the circumfernce of the parison the mandrel is simply pulled up so that the profiled end region becomes part of the flow channel. Then the thickness of the parison varies over the circumference. This according to the changing flow channel gap which then exists at the die end (see Fig.2).
The mandrel for instance is designed to be oval at its end for a simple round bottle. This is necessary to equalize the wall thickensses of the bottle at both ends of the weld line and perpendicular to the weld line. But that oval shape is not at all suited for the upper part of the bottle. Therefore the oval end geometry of the mandrel is continuously converted into a round geometry over a short length. Now when the part of the parison is discharged which is responsable for the weld line region of the blown article the oval end of the mandrel matches with the end of the die. The more the influence of the weld line vanishes the more the mandrel is pushed out of the die until the round geometry matches with the end of the die. This round mandrel geometry is then responsable for the parison thickness which is necessary for the rest of the bottle (Fig. 3). Thus the GWDS-technology can be easily retrofitted to every existing blow molding head. It neither affords a deformable die nor special actuators. It can be used with every existing blow molding machine without that the machine has to be modified in any way. Only the die of the head has to be exchanged. Although it needs only a solid die and a solid mandrel it enables to alter the wall thickness differently over the circumfernce of the parison while it is discharged. Without exception every blow molded article that is nowadays produced can be further improved in its quality in a very effective way using the GWDS-technology. The flow channel gap at the exit of the die can be easily altered by time matching the varying draw rations which exist for diffe-

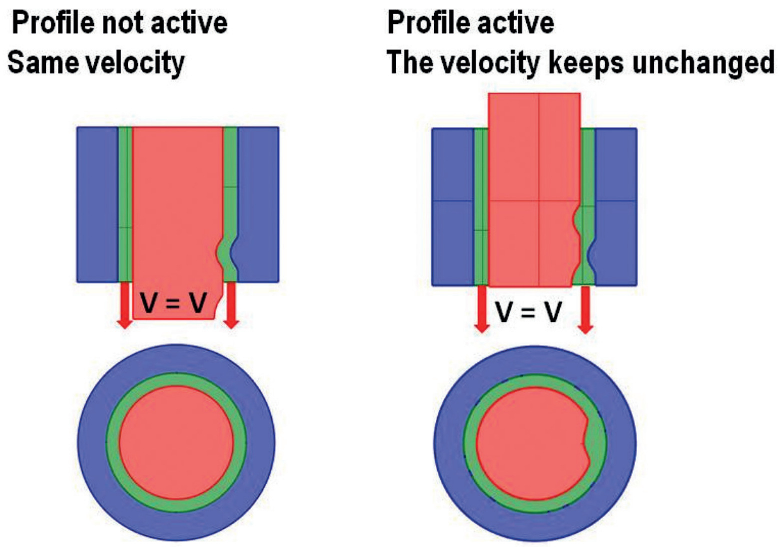


Fig 2
Cross sections of cylindrical GWDS-dies with diifferent position of the mandrel in order to alter the wall thickness of the parison over its circumernce in a locally limited way

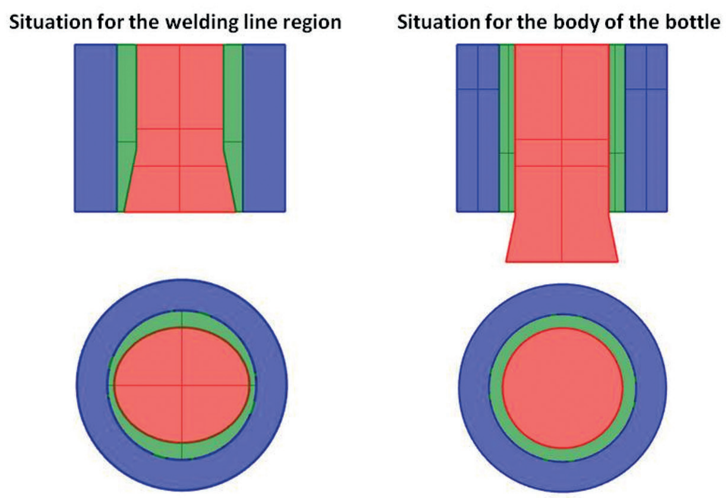


Fig. 3
Cross sectional drawings of a GWDS-die designed for the production of round bottles

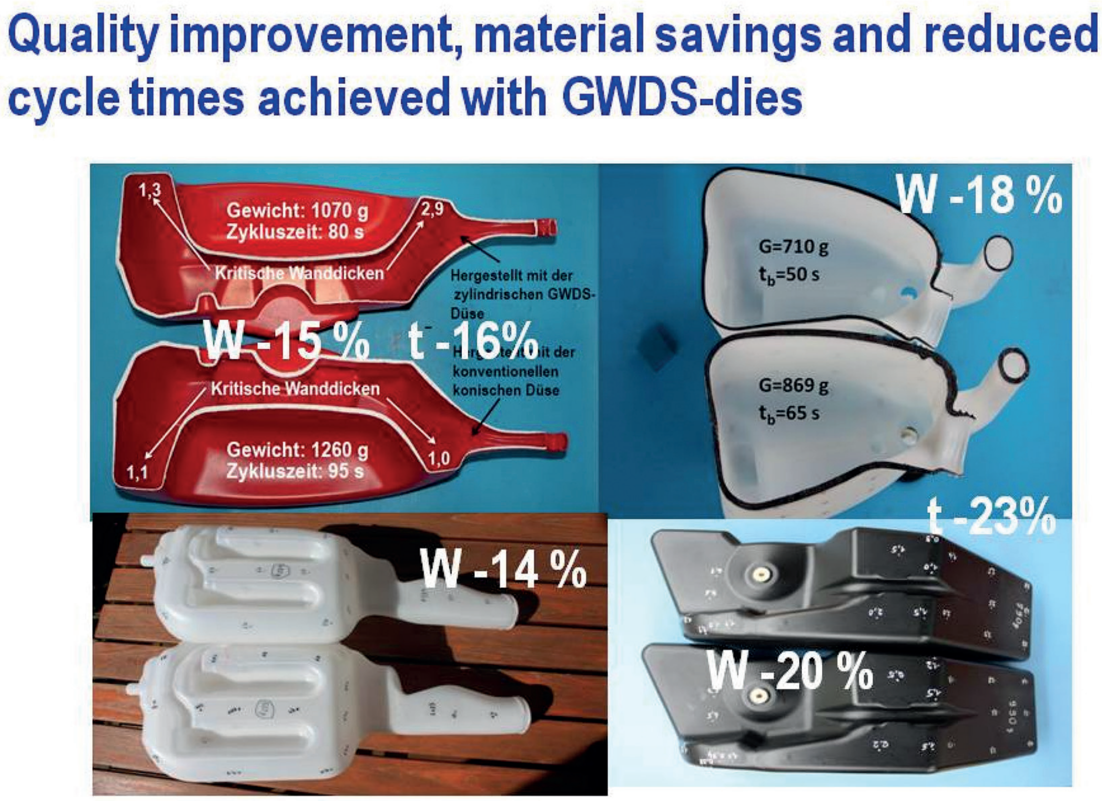


Fig. 4
Articles that have been produced with a conventional conical die and with a predominantly cylindrical GWDS-die

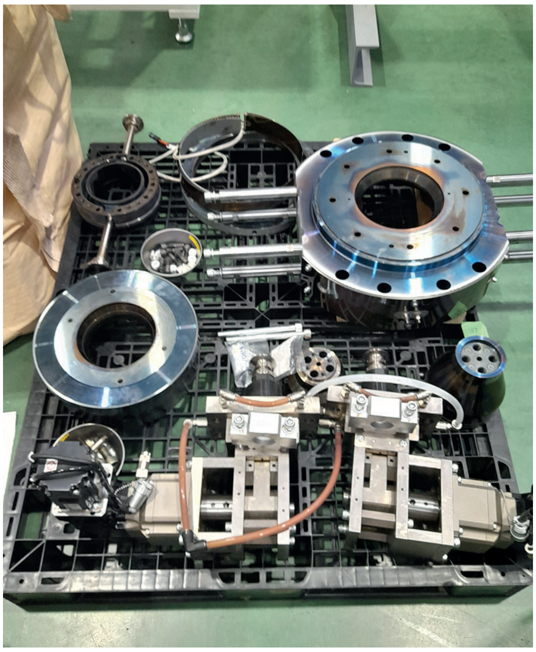
rent locatios of the part to be produced. A GWDS-die and mandrel do not need to be maintained in regular time intervals and they can not be responsible for potential machine break downs. This because a solid die and a solid mandrel can not fail during operation. In case a head is immediately equipped with a GWDS-die the fabrication cost of the head is comparable with that of a head which is equipped with a conventional conical die.

The economic value of the GWDS-technology

The GWDS-technology is a solution which cuts the cost to establish a dynamic radial wall thickness programming nearly to zero in comparison with the state of the art expensive PWDS-system. It helps to further improve the quality of blow molded articles. But in the same time it saves raw material, reduces the enregy consumption, cuts manpower requirements in the production, increases the capacity of the machines and thus increases the productivity. This due to the fact that it cuts the cycle time when avoiding thick wall regions in the part. As a consequence more articles can be produced per unit of time. Every existing head can be easly retrofitted with a solid GWDS-die and a solid GWDS-mandrel by only exchanging the existing conventional die and mandral. So it is very inexpensive to retrofit an existing head. As a consequence extrem short times can be reached until the investment will be paid back and significant improvements of the rate of return can be reached. Fig. 4 compares the wall thickness distributions, the weight and the cycle times achieved when producing four different articles with a conventional conical die and alternatively with a predominantly cylindrical GWDS-dies.

Using the following QR-codes short video can be seen which show the discharge of the parison for the part on top (left) and for the part shown on the bottom (right).

For over a decade in Europe nobody dares to replace a head that was equiped with a PWDS-system by a GWDS-die. Now an Asian blow molding machines producer of all companies dared to substitute his Asian copy of a PWDS-system by a GWDS-die. The company was forced to do that as the customer did not accept to pay for the ordered machine as they claimed that the weight of the 20 liter cans which were produced were too high. That is why the company decided to dismantle the Asian copy of a PWDS–system and to attache a solid GWDS-die and a soild mandrel (Fig. 5).



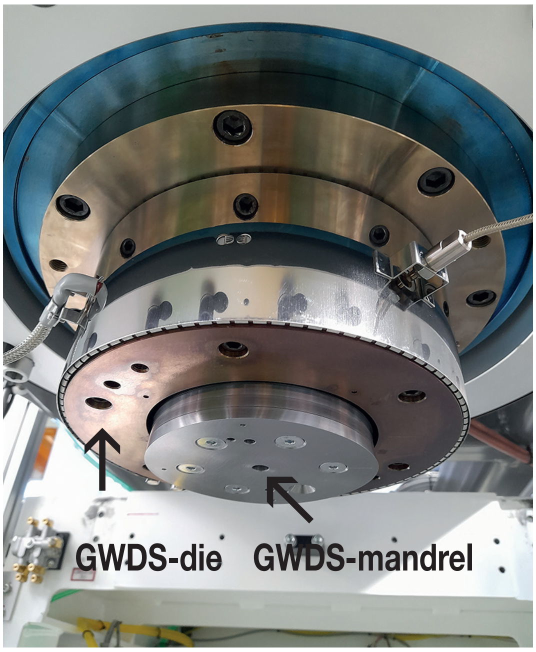


Fig. 5
Components of the Asian copy of a PWDS-system that has been dismantled from the head (left side) and GWDS-die and GWDS-mandrel that have been attached to the head instead (right side)

(Pictures: Dr.-Ing. Groß)

The company managed it to further reduce the weight of the cans by 5 %. In Europe some few producers of blow molded articlesc have already sucessfully replaced their conventional conical dies by GWDS-dies in order to further improve the quality of their parts. The quality was improved and the weight of the articles and the cycle time were reduced. But for what reason ever still no European machine producer has decided yet to design and to offer predominantly cylindrical GWDS-dies to their potential customers.